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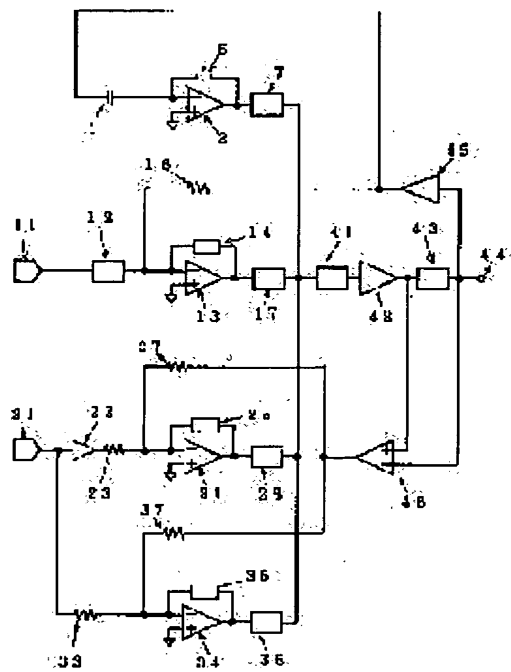
(54) MEASURING DEVICE OF VOLTAGE/CURRENT CHARACTERISTICS

(57)Abstract:
PURPOSE: To obtain a measuring device of voltage/current characteristics which suppresses a spike and an overshoot appearing in an output at the time of alteration of setting of a voltage/current to be supplied to an object of measurement and, besides, enables high-speed alteration of setting.
CONSTITUTION: In a measuring device of voltage/current characteristics, a V- hold loop having a capacitor 1, an error amplifier 3, an FET switch 5, a voltage/current converter 7, an integrating means 41, a power amplifier 42, a current range resistance means 43 and a buffer amplifier 45 is provided. At the time of an ordinary operation, the FET switch 5 is turned ON and an output voltage is stored in the capacitor 1. At the time of alteration of setting of a voltage/ current, a feedback circuit of the V-hold loop is formed by turning the FET switch 5 OFF, the output voltage is maintained at a value just before the alteration by using the voltage of the capacitor 1 as a reference, a voltage value and a current value are altered in the meantime, the feedback circuit of the V-hold loop is cut off at the time point of completion of the alteration and the measuring device of voltage/current characteristics is restored to a state of the ordinary operation.



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CLAIMS

[Claim(s)]
[Claim 1] Have the following and it has the 3rd control means by which the aforementioned error amplifier is connected to the aforementioned integrating circuit through the voltage-current converter. When the 1st control means of the above or the 2nd control means is controlling the aforementioned output voltage or the output current The 3rd control means of the above change to the state where the aforementioned voltage storage means memorizes the voltage of the aforementioned output voltage detection means, by the aforementioned control means for switching. When memorizing the aforementioned output voltage and changing the set point of either the aforementioned output voltage or the output current and both Change to the state where the 3rd control means of the above control output voltage by the aforementioned control means for switching first, and the control whose 3rd control means of the above hold the aforementioned output voltage on the voltage memorized by the aforementioned voltage storage means is started. After the 1st control means of the above and the 2nd control means suspend control automatically, The set point of the aforementioned voltage range, the reference voltage for output voltage, a current range, and/or the reference voltage for the output currents is changed. The control action of the 3rd control means of the above is suspended by the aforementioned control means for switching after the end during a transition stage of the aforementioned setting change. It is characterized by for the 1st control means of the above or the 2nd control means resuming control, and the 3rd control means of the above resuming storage of the voltage of the aforementioned output voltage detection means. The current range resistance circuit which detects the output current to which it connects with an output terminal and an end flows from the aforementioned output terminal to the measuring object. The integrating circuit connected to the input of the power amplifier which drives the other end of the aforementioned current range resistance circuit, and the aforementioned power amplifier, The 1st control means by which the error amplifier to which the reference voltage for output voltage was connected through the output voltage detection means and voltage range resistance circuit which detect the voltage of the aforementioned output terminal is connected to the aforementioned integrating circuit through the voltage-current converter, 2nd at least one control means by which the error amplifier to which the reference voltage for the output currents was connected through the output current detection means and resistance which detect the voltage of the ends of the aforementioned current range resistance circuit is connected to the aforementioned integrating circuit through the voltage-current converter, ************, the volt ampere characteristic measuring device which controls the aforementioned output voltage by the 1st control means of the above to a predetermined value, or controls the aforementioned output current by the 2nd control means of the above to a predetermined value. A voltage storage means by which the end was connected to the aforementioned output voltage detection means, and the other end was connected to the input of error amplifier Control means for switching connected between I/O of the aforementioned error amplifier
[Claim 2] The volt ampere characteristic measuring device according to claim 1 carry out the aforementioned voltage storage means of the 3rd control means of the above changing with a capacitor, and the aforementioned control means for switching changing with an FET switch, short-circuiting the aforementioned FET switch, charging the voltage corresponding to output voltage to the aforementioned capacitor, opening the aforementioned FET switch wide, and controlling so that the aforementioned output voltage is held on the basis of the voltage charged to the aforementioned capacitor at the output voltage in front of opening of the aforementioned FET switch as the feature.
[Claim 3] The 3rd control means of the above connect the end of a capacitor to the aforementioned output voltage detection means. The other end of the aforementioned capacitor is connected to the input edge of the aforementioned error amplifier through resistance. Connect between I/O of the aforementioned error amplifier with the 1st FET switch, and the ends of the aforementioned resistance are connected with the 2nd FET switch. 2FET switch is short-circuited. the output of the aforementioned error amplifier -- the aforementioned voltage current repeater -- minding -- the aforementioned integrating circuit -- connecting -- changing -- the [the aforementioned 1st FET switch and] -- 2FET switch is opened wide. the voltage corresponding to output voltage to the aforementioned capacitor -- charging -- the [the aforementioned 1st FET switch and] -- criteria [voltage / which charged the aforementioned capacitor] -- carrying out -- the aforementioned output voltage -- the / the aforementioned 1st FET switch and / -- the volt ampere characteristic measuring device according to claim 1 characterized by controlling to be held at the output voltage in front of opening of 2FET switch
[Claim 4] the [the aforementioned 1st FET switch and] -- the volt ampere characteristic measuring device according to claim 3 characterized by performing short circuit of 2FET switch, and change control of opening by the lamp wave
[Claim 5] between the node of the aforementioned capacitor and the aforementioned resistance of the 3rd control means of the above, and the outputs of the aforementioned error amplifier -- a clamping circuit -- connecting -- changing -- the [the aforementioned 1st FET switch and] -- the volt ampere characteristic measuring device according to claim 4 characterized by preventing the malfunction of 2FET switch
[Claim 6] The 1st control means of the above and the 2nd control means connect an FET switch between I/O of each aforementioned error amplifier. The period when the 1st control means of the above or the 2nd control means controls the aforementioned output voltage or the output current After starting the control whose 3rd control means of the above open the aforementioned FET switch wide and hold output voltage, The volt ampere characteristic measuring device according to claim 1 characterized by short-circuiting the aforementioned FET switch, changing the set point of the aforementioned voltage range, the reference voltage for output voltage, a current range, and/or the reference voltage for the output currents, and opening the aforementioned FET switch immediately after the end during a transition stage of the aforementioned setting change.
[Claim 7] The 1st control means of the above and the 2nd control means have a means to stop the function of the

aforementioned voltage current repeater. After the 3rd control means of the above start control holding output voltage, the function of the aforementioned voltage current repeater of the 1st control means of the above and the 2nd control means is stopped. The volt ampere characteristic measuring device according to claim 1 characterized by changing the set point of the aforementioned voltage range, the reference voltage for output voltage, a current range, and/or the reference voltage for the output currents, and recovering the function of the aforementioned voltage current repeater immediately after the end during a transition stage of the aforementioned setting change.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Generally, this invention relates to the volt ampere characteristic measuring device especially used for a semiconductor direct-current parameter measuring device with respect to the method of shortening the time which setting change of the method of mitigating the spike and over shoot which appear in an output and voltage, or current takes, when changing the output voltage of a power supply, or a setup of the output current.
[0002]
[Description of the Prior Art] Although detailed-ization of semiconductor technology has a remarkable thing in recent years, in connection with it, a semiconductor product is becoming weak to stress. Therefore, the equipment which measures a semiconductor is also required not to give a unnecessary stress to the semiconductor which is the measuring object. Moreover, there is a demand which wants to shorten time which product inspection takes as much as possible, therefore it is necessary to shorten the switching time between each parameter as much as possible in the semiconductor testing device used especially with a production line.
[0003] The volt ampere characteristic measuring device used for a semiconductor direct-current parameter measuring device is equipment which current is passed from a constant current source to the measuring object, and can measure [measuring the current which impresses voltage to the measuring object from the source of a constant voltage, and flows there, and] the voltage of the ends of the measuring object. In addition, the volt ampere characteristic measuring device is used as the parametric measurement unit (PMU) in the field of the semiconductor circuit testing device which the applicant for this patent sells, and a voltage-current measurement unit (SMU) in the field of a semiconductor direct-current parameter measuring device.
[0004] In order to perform above-mentioned measurement, a volt ampere characteristic measuring device is equipped with the three modes, the source mode of a constant voltage, positive-definite current-source mode, and negative constant-current-source mode, supplies a power supply to the measuring object in any these one mode, and measures voltage or current. These modes are illustrated on the coordinate to which drawing 4 makes a horizontal axis voltage and makes a vertical axis current.
[0005] The source mode of a constant voltage is the mode in which the absolute value of the output current is a range below I, and output voltage is constant value V (it is here and I and V are a positive value). That is, the straight line of the length which connects between the coordinate (V, I) of drawing 4 , and (V, -I) expresses the source mode of a constant voltage. In addition, although it is [absolute value / of I of positive/negative] and there is no need, on these specifications, it considers as the equal for simplification of the following explanation.
[0006] Positive-definite current mode is the mode in which output voltage is a range below V and the output current is constant value I. A straight line parallel to the horizontal axis extended on the left from a coordinate (V, I) expresses positive-definite current-source mode with drawing 4 . Moreover, for output voltage, the output current is [negative constant-current-source mode] constant value at the range more than V. - It is the mode which is I. A straight line parallel to the horizontal axis extended on the right from a coordinate (V, -I) expresses this mode with drawing 4 . The chip box line of a crank form which compounded these three modes expresses the volt ampere characteristic of a volt ampere characteristic measuring device.
[0007] Here, V of the above-mentioned source of a constant voltage is made to call a control-voltage value and I of a constant current source control current value. Although the control-voltage value and the control current value are always set as a certain value, it is not decided only by the set point of V and I which mode the present power supply will be, but it is related also to the resistance of the measuring object. It is shown that the resistance of the measuring object is related to the determination in the mode at drawing 5 , and signs that the mode changes by change of V or I further are illustrated. Resistance is resistance of R and the measuring object of drawing 5 shows the example in which the other end is grounded. The volt ampere characteristic is expressed with the straight line of the upward slant to the right [inclination] of 1/R. An intersection with the chip box line showing the volt ampere characteristic of this straight line and a volt ampere characteristic measuring device is the operating point of resistance, and is also the operating point of a volt ampere characteristic measuring device. Moreover, the portion of a chip box line with the operating point shows the mode of a volt ampere characteristic measuring device.
[0008] In drawing 5 , first, the volt ampere characteristic measuring device is set as V=V1 and I=I1, and presupposes that the current (however, less than [I1]) of V1/R is flowing for resistance. At this time, a volt ampere characteristic measuring device is the source mode of a constant voltage. Here, V is raised to V2 (however, V2 below I1 and R). Although the output current increases to V2/R as a result, since this value is less than [I1], the mode does not change but current value only changes to a new value. Next, V is changed into V3. V3/R presupposes that it is larger than I1 here. At this time, a volt ampere characteristic measuring device cannot output Current V3/R in the source mode of a constant voltage, but it changes, becomes constant-current-source mode, and falls and attaches the mode to the operating point of the output current I1, and output voltage I1 and R.
[0009] Although the above is an example to which a control-voltage value changes a control-voltage value, and changes in constant-current-source mode from the source mode of a constant voltage of V1, even if it changes a control current value, there may be changes in the mode. In the source mode of a constant voltage of the initial state of drawing 5 , if a control current value is changed into below I1 to V1 / R, it turns out easily that it changes in constant-current-source mode.
[0010] Moreover, although the example to which it changes in the source mode of a constant voltage when an initial state changes a control-voltage value or a control current value in constant-current-source mode is not shown, it changes in the same operation as the above.

[0011] The basic block diagram of the volt ampere characteristic measuring device of the conventional technology is shown in drawing 3 . Drawing 3 shows only the component related to this invention stated to basic operation of a volt ampere characteristic measuring device, and the back, and components, such as an operation control section which performs amendment meanses, such as a feedback circuit, range change, and various signal processing and control, are omitted.
[0012] In order to realize the source mode of a constant voltage, positive-definite current-source mode, and negative constant-current-source mode with the above-mentioned volt ampere characteristic, the volt ampere characteristic measuring device is equipped with the feedback loop called V loop, Ip loop, and In loop corresponding to the three modes. In drawing 3 , the feedback circuit which consists of DA converter 11, the voltage range resistance circuit 12, the error amplifier 13, the voltage-current converter 17, the integration means 41, power amplifier 42, the current range resistance circuit 43, a buffer amplifier 45, and resistance 16 is V loop. By the output terminal of a volt ampere characteristic measuring device, the measuring object is connected for a terminal 44 between this terminal and grounding or between the output terminals of other voltage amperometry equipments.
[0013] Ip loops are DA converter 21, an inverting amplifier 22, resistance 23, the error amplifier 24, the voltage-current converter 28, an integrating circuit 41, power amplifier 42, the current range resistance circuit 43, the differential amplifier 46, and a feedback circuit that consists of resistance 27. In loops are DA converter 21, resistance 33, the error amplifier 34, the voltage-current converter 38, an integrating circuit 41, power amplifier 42, the current range resistance circuit 43, the differential amplifier 46, and a feedback circuit that consists of resistance 37. In addition, drawing 3 is positive and an example when the absolute value of the control current in negative constant-current mode is equal. When not equal, an inverting amplifier 22 is unnecessary and impresses reference voltage to resistance 33 from DA converter with 21 [another].
[0014] Here, the voltage range resistance circuit 12 and the current range resistance circuit 43 usually consist of FET switches which switch two or more range resistance and them. The voltage range resistance circuit 12 sets up the range of a control-voltage value, and DA converter 11 sets up the value in a range. In the case of a control current value, the current range resistance circuit 43 sets up a range, and DA converter 21 sets up the value in a range. Moreover, an integrating circuit consists of capacitors usually connected between the input of power amplifier, and grounding.
[0015] Furthermore, between I/O of the error amplifier 13, 24, and 34, clamping circuits 14, 25, and 35 are connected, respectively, and the output of error amplifier becomes more than the clamp voltage (Vc) decided by the clamping circuit.
[0016] Below, the relation of the input voltage pair output current of the voltage current repeaters 17, 28, and 38 is shown in drawing 6 . Although it changes in proportion [almost] to input voltage, the output current is set up so that it may be saturated in the range with the larger absolute value of input voltage than Vs of drawing 6 . The voltage current repeater 17 of V loop is the property of a point symmetry mostly to a zero, and the size of the saturation current is Is. On the other hand, it is in the property of the voltage-current converter 28 so that the saturation current by the side of right voltage may become zero mostly in the voltage-current converter 28 of Ip loop. - It is the property which required the bias of Is. Moreover, the voltage-current converter 38 of In loop is the property which required the bias of +Is. Moreover, input voltage does not become more than clamp-voltage Vc of above-mentioned error amplifier.
[0017] In addition, the inclination for a ramp of the input-output behavioral characteristics of these voltage-current converters does not need to be equal.
[0018] Below, operation of each loop is described. V loop presupposes first that feedback control is performed. At this time, the difference of a buffer amplifier 45, the voltage which returned to the input of the error amplifier 13 through resistance 16, and the voltage on which the voltage of DA converter 11 was applied to the input of the error amplifier 13 through the voltage range resistance circuit 12 is amplified with the error amplifier 13 from an output terminal 44, and the current which is equivalent to difference voltage from the voltage current repeater 17 is outputted. An integrating circuit 41 is integrated with this current, and it serves as an input of power amplifier 42. By the negative feedback of such a V loop, the ratio of the voltage of an output terminal 44 and the voltage of a DA converter balances so that it may become equal to the ratio of the resistance of resistance 16 and the voltage range resistance circuit 12. In this state, since, as for the input voltage of regularity 42, i.e., power amplifier, output voltage is maintained at simultaneously regularity, the current inputted into an integrating circuit 41 is zero mostly.
[0019] On the other hand, since the output current is a value smaller than a control current value while V loop is performing feedback control, the input of the error amplifier 24 of Ip loop has negative voltage of the size which saturates error amplifier. For this reason, the output of the error amplifier 24 is clamped by the voltage Vc positive by the clamping circuit 25. By moreover, the reason nil why the error amplifier 34 of In loop also has the conversely same polarity but - It is clamped by Vc. Therefore, Ip and In loop are in the state where feedback control cannot be carried out. Since the input voltage of the voltage-current converters 28 and 38 of Ip and In loop is set to Vc and -Vc, respectively at this time, the output current is zero mostly, as shown in drawing 6 . Although the sum of the current of three voltage-current converters is current inputted into an integrating circuit 41, the current of the voltage current repeater 17 is tuned finely, and a feedback circuit balances so that the flowing current may become zero mostly.
[0020] When Ip or In loop performs feedback control, except for the following point, it is the same as that of the case of V loop. That is, the voltage to which feedback voltage is proportional to the current of the ends of not output voltage but the current range resistance circuit 43 is returned. The resistance 23 and 33 of the position equivalent to a voltage range resistance circuit does not have the need for ranging. Moreover, the inverting amplifier 22 which reverses the polarity of DA converter 21 for Ip loop from which polarity differs, and In loop is formed. Furthermore, although omitted for details, as for the output current of each voltage-current converter in the state where the feedback circuit balances, not zero but the whole sum is zero.
[0021] Moreover, measurement of voltage and current is performed by the following method. The input impedance of the differential amplifier 46 is almost infinite, since the output voltage is proportional to the output current of a volt ampere characteristic measuring device, it can measure with the voltmeter which is not illustrating this voltage, and the current value which flows to the measuring object can be calculated. Moreover, since the output voltage of a buffer amplifier 45 is equal to the output voltage of a volt ampere characteristic measuring device, it can measure with the voltmeter which is not illustrating this voltage, and the voltage value of the measuring object can be calculated.
[0022] The example which changes from the source mode of a constant voltage shown in drawing 5 to constant-current-source mode describes operation which moves from one of the above-mentioned 3 modes to other modes. The introduction control-voltage value presupposes that V1 and a control current value are in the source mode of a constant voltage by I1. At this time, V loop performs feedback control, and is in equilibrium, and the error amplifier of Ip loop and In loop is clamped.
[0023] Here, supposing it enlarges a control-voltage value to V3, output voltage increases in feedback control operation of V loop, the output current increases, and it is going to exceed the control current value I1. At this time, the input voltage of the

error amplifier 24 of Ip loop becomes close to zero, the error amplifier 24 is released from a clamp state, and the input voltage of the voltage current repeater 28 is also released from a saturation region. The voltage-current converter 28 absorbs current from an integrating circuit, in order to absorb current as shown in drawing 6 , if input voltage falls. On the other hand, by In loop, since a programmed current differs from the output current greatly, a clamp state is continued, and the current of the voltage-current converter 38 is maintaining the zero state. Consequently, it works in the direction in which Ip loop lowers the input voltage of power amplifier 42, and lowers output voltage further.
[0024] On the other hand, by V loop, since output voltage is still lower than the set point V3, the output of the error amplifier 13 increases and is made into how to flow out the output current of the voltage-current converter 17. Although the voltage-current converter 17 and the voltage-current converter 28 carry out operation of an opposite direction mutually here, as shown in drawing 6 , since the upper limit Is into which the voltage current repeater 17 can flow is smaller than the upper limit (about 2 Is (es)) of the current which can absorb the voltage-current converter 28, the voltage current repeater 17 is saturated previously. An output is raised and it will be in the state in which feedback control is impossible until the error amplifier 13 is also clamped after all. Thus, a feedback circuit balances in the state where the saturation current of the voltage current repeater 17 is absorbed by the voltage-current converter 28, V loop separates from the state of constant-voltage control, Ip loop will be in the state of carrying out constant current control, and the output current will be maintained at constant value.
[0025] In addition, when a voltage setup changes to V2 from V1, with a bird clapper, since there is no error voltage of an input of the error amplifier 24 of Ip loop in zero, it will maintain the armature-voltage control state of V loop to them, and will turn into voltage V2 soon at them.
[0026] As mentioned above, the volt ampere characteristic measuring device has two or more feedback circuits, in order to perform source mode of a constant voltage, positive-definite current-source mode, and negative constant-current-source mode. If at least one parameter which has determined the state of the feedback circuit in equilibrium is changed including that the frequency response of these feedback circuits is limited, and two or more pole for a ** reason, a spike and overshoot will occur in an output. Since two or more feedback circuits interchange the feedback operation idle state and feedback control operating state which have been saturated and clamped when the mode of a power supply changes, a big spike and big overshoot occur especially. Such spikes and overshoot give a unnecessary stress to a measuring object semiconductor.
[0027] Various methods of stopping a spike and an over shoot from the former have been devised. They are illustrated below.
[0028] (a) It is the method of stopping the abrupt change of a feedback loop, by inserting a low-passed type filter in the output of the DA converter which sets the method control-voltage value and control current value which prepare a filter as the output of a DA converter, and stopping the abrupt change of a DA converter output.
[0029] (b) Range change of the method control-voltage value which makes a DA converter zero temporarily at the time of voltage range change is the voltage range resistance circuit 12, and is performed by switching resistance (not shown). In order to prevent the spike at the time of ranging in the source mode of a constant voltage, and overshoot, it is the method of once making a setup of DA converter 11 into zero, changing range resistance in the state, and setting a DA converter as a desired value after that.
[0030] (c) If this voltage value becomes small in the method constant-current-source mode which carries out a makeup before breaking change in a voltage range resistance circuit in the setting change accompanied by change of a control-voltage value, when it will be predicted that mode changes arise, it is the method the resistance change (not shown) of a voltage range resistance circuit is made to become with makeup before breaking. Since parallel connection of the range resistance of two before and behind a change is temporarily carried out to the period of a change by this, output voltage does not sway to the method of a low during a change. Therefore, the unnecessary loop changes under range resistance change are avoided, and a spike and generating of overshoot are suppressed.
[0031] (d) If this voltage value becomes large in the method constant-current-source mode which carries out a breaking before makeup change in a voltage range resistance circuit in the setting change accompanied by change of a control-voltage value, when it will be predicted that mode changes arise, it is the method the change of range resistance is made to serve as a breaking before makeup. Thereby, temporarily during the change, range resistance is small, with a bird clapper, there is nothing and output voltage does not sway to the larger one. Therefore, the unnecessary loop changes under range resistance change are avoided, and a spike and generating of overshoot are suppressed.
[0032] (e) In the source mode transformation method present constant-current-source mode of a constant voltage, when changing resistance (not shown) of the current range resistance circuit 43, change a control-voltage value and make it first, the source mode of a constant voltage compulsorily so that the present operating point may hardly change. Then, it is the method of changing the resistance of a current range resistance circuit.
[0033] (f) In the source mode of a method present constant voltage in which I loop is cut, when making a setting change accompanied by change of resistance of a current range resistance circuit, make the voltage-current converter of Ip loop and In loop into a functional idle state, and cut each feedback loop of Ip loop and In loop. After making a current-related setting change and completing all change, it is the method of reviving the feedback loop of Ip loop and In loop.
[0034] (g) Since the current range resistance circuit 43 is also the component of V loop even if it carries out a functional halt of the voltage-current converter of the soft switch method current loop, when switching current range resistance, a spike or overshoot will appear in an output. Then, it is the method of making it into ** to which the FET switch which switches current range resistance is driven by the lamp voltage wave, and change of range resistance becomes slower than the frequency response of V loop.
[0035] The above-mentioned conventional technology was combined, and it chose according to the present state, and the purpose which stops a spike and an over shoot can be attained. However, there are the following problems in these.
(1) Although one setting change is made, you have to operate two or more steps. Therefore, setting change takes time.
(2) Since a low pass filter, a soft switch, etc. of a DA converter make a setting change gradually, setting change takes time.
(3) Since the present mode must be supervised, a suitable method must be chosen from two or more change methods which predicted and mentioned the mode after setting change above and the sequence of operation must be switched, control is complicated and the burden of the firmware of an operation control section is size.
(4) According to above (1) and (2) term, a demand of the commercial scene of wanting to shorten the measuring time cannot be satisfied.
[0036]
[Problem(s) to be Solved by the Invention] this invention -- a spike and an over shoot -- stopping -- in addition -- and the volt ampere characteristic measuring device in which a high-speed setting change is possible is offered Furthermore the complicated

control at the time of setting change of the conventional technology is simplified, and the load of the firmware which controls is mitigated.
[0037]
[Means for Solving the Problem] In addition to V loop, Ip loop, and In loop of the conventional technology, this invention newly establishes V hold loop. This loop has memorized output voltage by the output voltage store circuit at the time of the usual operation of a volt ampere characteristic measuring device. The feedback circuit of V hold loop is formed at the time of change of a control voltage and current value, and this feedback circuit maintains output voltage to the value in front of change on the basis of the storage voltage of an output voltage store circuit. Both a control-voltage value, and control current both [either or] are changed between them. When change is completed, the feedback circuit of V hold loop is cut and a volt ampere characteristic measuring device returns to a normal operating state.
[0038]
[Example] The basic composition of the example of this invention is shown in drawing 1 . The same sign is given to the component of the same function as the conventional technology. In addition, drawing 1 shows only the component about basic operation of a volt ampere characteristic measuring device, and components, such as an operation control section which performs amendment meanses, such as a feedback circuit, range change, and various signal processing and control, are omitted.
[0039] The basic composition of V hold loop is a loop which takes a round of the capacitor 1 which is an output voltage store circuit, the error amplifier 3, the FET switch 5, the voltage-current converter 7, an integrating circuit 41, power amplifier 42, the current range resistance circuit 43, and a buffer amplifier 45. An integrating circuit 41, power amplifier 42, the current range resistance circuit 43, and a buffer amplifier 45 are V loop of the conventional technology, Ip loop and In loop, and a common loop arrangement element.
[0040] There is two operating state, output voltage truck operation and output voltage maintenance operation, in V hold loop. Output voltage maintenance operation is operation of a period which changes the control voltage and current value of a volt ampere characteristic measuring device, and the purpose is maintaining output voltage to constant value. Output voltage truck operation is operation of the period of the normal operating state which change of a volt ampere characteristic measuring device completed, and the purpose is following output voltage and memorizing voltage.
[0041] In output voltage truck operation, the FET switch 5 is closed, the feedback loop of V hold loop is cut, and feedback control operation is stopped.
[0042] If the FET switch 5 is closed, since the error amplifier 3 will be in all feedback states and the input/output terminal will be held at a zero potential, a feedback loop is cut. Since the input terminal of error amplifier is maintained at zero, the potential of the terminal by the side of the error amplifier of a capacitor 1 is zero. Moreover, voltage with other terminals of a capacitor 1 equal to the output voltage of a buffer amplifier 45 to a volt ampere characteristic measuring device is always impressed. Consequently, voltage equal to a capacitor 1 to output voltage can always be charged.
[0043] When changing the control voltage and current value of a volt ampere characteristic measuring device, the feedback loop of V hold loop currently cut first is made to form, and it switches to output voltage maintenance operation. The FET switch 5 is opened to this. The voltage-current converter 7 of this loop has set up the dynamic range of a current output greatly from the voltage-current converter of V loop, Ip loop, and In loop, as the dotted line of drawing 7 shows. That is, it has set up beyond the value to which the current value at the time of saturation exceeds 3 times of the saturation current Is of the voltage-current converter 17.
[0044] If V hold loop forms a feedback loop, the difference voltage of the voltage charged by the capacitor 1 and voltage equal to the output voltage impressed from a buffer amplifier 45 is inputted into the error amplifier 3, and it is going to carry out feedback control of the V hold loop so that it may become zero about this difference voltage. Although V loop or I loop which carried out feedback control and had determined output voltage before it, and V hold loop compete for output voltage simultaneously, the voltage-current converter of V loop with the small die NAMMIKU range of a voltage-current converter or I loop is saturated previously, and, finally V hold loop comes to control. And the error amplifier of the loop which was carrying out feedback control till then will be in a clamp state.
[0045] Even if feedback control changes a control voltage and/or current value into during this period [from which it has moved to V hold loop] at a stretch, influence does not appear in an output. After completing change, if the loop of V hold loop is cut, feedback control will return to either V loop, Ip loop or In loop according to a new value.
[0046] Although a spike and overshoot are reduced by operation of V hold loop of the above-mentioned basic composition, a new spike and new overshoot may arise by changes between V hold loop and the usual loop. The detailed example which gave a means to have removed this and to improve the stability of feedback operation of V hold loop is shown in drawing 2 . However, drawing 2 shows only the component about basic operation, and components, such as an operation control section which performs amendment meanses, such as a feedback circuit including V hold loop, range change, and various signal processing and control, are omitted.
[0047] In drawing 2 , resistance 2 was inserted between the capacitor 1 of V hold loop, and the error amplifier 3, and the FET switch 4 is connected in parallel with this resistance. Moreover, the clamping circuit 6 is connected between a capacitor 1, the node of resistance 2, and the output terminal of the error amplifier 3. Furthermore, the FET switches 15, 26, and 36 are connected between I/O of the error amplifier of V loop, Ip loop, and In loop. These operations are described below.
[0048] (A) V hold loop changes the voltage current repeater of output voltage maintenance working, V loop, Ip loop, and In loop into an abeyance state. Generating of the spike which may be produced transitionally by this is prevented. The conversion efficiency of a voltage-current converter is with a bird clapper in equivalent at zero, and the abeyance state of a voltage current repeater is **. Therefore, in order to realize it, the interior of a voltage-current converter which cuts the input of a voltage current repeater is controlled, and an output is intercepted, or there is the method of intercepting an outgoing end.
[0049] (B) Make into a value almost equal to the feedback resister 16 of V loop resistance 2 inserted between the capacitor 1 and the input of the error amplifier 3, and improve the stability of the feedback loop of V hold loop. Resistance 2 is short-circuited with the FET switch 4, and it is made for the delay of a hold not to arise during output voltage truck operation.
[0050] (C) If the change of output voltage maintenance operation of V hold loop and output voltage truck operation is performed at a stretch, since a new spike occurs, the change timing of the FET switches 4, 5, and 7 will be adjusted according to the charge transfer from the FET switches 4 and 5 etc. by the soft change method which drives a change by the lamp wave.
[0051] (D) Since overshoot may occur when output voltage maintenance operation is completed and it returns to the usual operation of a volt ampere characteristic measuring device if it is in the state where the error amplifier of V loop, Ip loop, and In loop was clamped for V hold loop during output voltage maintenance operation, short-circuit I/O of the error amplifier 13, 24, and

34 with the FET switches 15, 26, and 36 during output voltage maintenance operation, respectively.
[0052] (E) Connect a clamping circuit 6 to V hold loop, and prevent an FET switch malfunctioning during output voltage maintenance operation.
[0053] A spike and overshoot were lost by the above-mentioned method, and a high-speed setting change was attained by simple control.
[0054] Although the example of this invention was shown above, the format of instantiation, arrangement, and others are not limited, and deformation of composition is also permitted, without losing the summary of this invention if needed.
[0055]
[Effect of the Invention] according to this invention -- a spike and generating of overshoot -- enough -- it can stop -- the conventional technology -- several ms -- since -- the setting change time which required about 10ms can be shortened or less to 1/10 Consequently, it presents [can measure a semiconductor property now at high speed, and] practical use and is useful. furthermore, since the method of switching the control method according to the state where it is expected after required present state and setup with the conventional technology became unnecessary, control by the firmware reaches to an extreme, it can be simplified now, and shortening of a development cycle can be aimed at

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[Translation done.]

TECHNICAL FIELD

[Industrial Application] Generally, this invention relates to the volt ampere characteristic measuring device especially used for a semiconductor direct-current parameter measuring device with respect to the method of shortening the time which setting change of the method of mitigating the spike and over shoot which appear in an output and voltage, or current takes, when changing the output voltage of a power supply, or a setup of the output current.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Although detailed-ization of semiconductor technology has a remarkable thing in recent years, in connection with it, a semiconductor product is becoming weak to stress. Therefore, the equipment which measures a semiconductor is also required not to give a unnecessary stress to the semiconductor which is the measuring object. Moreover, there is a demand which wants to shorten time which product inspection takes as much as possible, therefore it is necessary to shorten the switching time between each parameter as much as possible in the semiconductor testing device used especially with a production line.
[0003] The volt ampere characteristic measuring device used for a semiconductor direct-current parameter measuring device is equipment which current is passed from a constant current source to the measuring object, and can measure [measuring the current which impresses voltage to the measuring object from the source of a constant voltage, and flows there, and] the voltage of the ends of the measuring object. In addition, the volt ampere characteristic measuring device is used as the parametric measurement unit (PMU) in the field of the semiconductor circuit testing device which the applicant for this patent sells, and a voltage-current measurement unit (SMU) in the field of a semiconductor direct-current parameter measuring device.
[0004] In order to perform above-mentioned measurement, a volt ampere characteristic measuring device is equipped with the three modes, the source mode of a constant voltage, positive-definite current-source mode, and negative constant-current-source mode, supplies a power supply to the measuring object in any these one mode, and measures voltage or current. These modes are illustrated on the coordinate to which drawing 4 makes a horizontal axis voltage and makes a vertical axis current.
[0005] The source mode of a constant voltage is the mode in which the absolute value of the output current is a range below I, and output voltage is constant value V (it is here and I and V are a positive value). That is, the straight line of the length which connects between the coordinate (V, I) of drawing 4 , and (V, -I) expresses the source mode of a constant voltage. In addition, although it is [absolute value / of I of positive/negative] and there is no need, on these specifications, it considers as the equal for simplification of the following explanation.
[0006] Positive-definite current mode is the mode in which output voltage is a range below V and the output current is constant value I. A straight line parallel to the horizontal axis extended on the left from a coordinate (V, I) expresses positive-definite current-source mode with drawing 4 . Moreover, for output voltage, the output current is [negative constant-current-source mode] constant value at the range more than V. - It is the mode which is I. A straight line parallel to the horizontal axis extended on the right from a coordinate (V, -I) expresses this mode with drawing 4 . The chip box line of a crank form which compounded these three modes expresses the volt ampere characteristic of a volt ampere characteristic measuring device.
[0007] Here, V of the above-mentioned source of a constant voltage is made to call a control-voltage value and I of a constant current source control current value. Although the control-voltage value and the control current value are always set as a certain value, it is not decided only by the set point of V and I which mode the present power supply will be, but it is related also to the resistance of the measuring object. It is shown that the resistance of the measuring object is related to the determination in the mode at drawing 5 , and signs that the mode changes by change of V or I further are illustrated. Resistance is resistance of R and the measuring object of drawing 5 shows the example in which the other end is grounded. The volt ampere characteristic is expressed with the straight line of the upward slant to the right [inclination] of 1/R. An intersection with the chip box line showing the volt ampere characteristic of this straight line and a volt ampere characteristic measuring device is the operating point of resistance, and is also the operating point of a volt ampere characteristic measuring device. Moreover, the portion of a chip box line with the operating point shows the mode of a volt ampere characteristic measuring device.
[0008] In drawing 5 , first, the volt ampere characteristic measuring device is set as V=V1 and I=I1, and presupposes that the current (however, less than [I1]) of V1/R is flowing for resistance. At this time, a volt ampere characteristic measuring device is the source mode of a constant voltage. Here, V is raised to V2 (however, V2 below I1 and R). Although the output current increases to V2/R as a result, since this value is less than [I1], the mode does not change but current value only changes to a new value. Next, V is changed into V3. V3/R presupposes that it is larger than I1 here. At this time, a volt ampere characteristic measuring device cannot output Current V3/R in the source mode of a constant voltage, but it changes, becomes constant-current-source mode, and falls and attaches the mode to the operating point of the output current I1, and output voltage I1 and R.
[0009] Although the above is an example to which a control-voltage value changes a control-voltage value, and changes in constant-current-source mode from the source mode of a constant voltage of V1, even if it changes a control current value, there may be changes in the mode. In the source mode of a constant voltage of the initial state of drawing 5 , if a control current value is changed into below I1 to V1 / R, it turns out easily that it changes in constant-current-source mode.
[0010] Moreover, although the example to which it changes in the source mode of a constant voltage when an initial state changes a control-voltage value or a control current value in constant-current-source mode is not shown, it changes in the same operation as the above.
[0011] The basic block diagram of the volt ampere characteristic measuring device of the conventional technology is shown in drawing 3 . Drawing 3 shows only the component related to this invention stated to basic operation of a volt ampere characteristic measuring device, and the back, and components, such as an operation control section which performs amendment meanses, such as a feedback circuit, range change, and various signal processing and control, are omitted.
[0012] In order to realize the source mode of a constant voltage, positive-definite current-source mode, and negative constant-current-source mode with the above-mentioned volt ampere characteristic, the volt ampere characteristic measuring device is equipped with the feedback loop called V loop, Ip loop, and In loop corresponding to the three modes. In drawing 3 , the feedback

circuit which consists of DA converter 11, the voltage range resistance circuit 12, the error amplifier 13, the voltage-current converter 17, the integration means 41, power amplifier 42, the current range resistance circuit 43, a buffer amplifier 45, and resistance 16 is V loop. By the output terminal of a volt ampere characteristic measuring device, the measuring object is connected for a terminal 44 between this terminal and grounding or between the output terminals of other voltage amperometry equipments.
[0013] Ip loops are DA converter 21, an inverting amplifier 22, resistance 23, the error amplifier 24, the voltage-current converter 28, an integrating circuit 41, power amplifier 42, the current range resistance circuit 43, the differential amplifier 46, and a feedback circuit that consists of resistance 27. In loops are DA converter 21, resistance 33, the error amplifier 34, the voltage-current converter 38, an integrating circuit 41, power amplifier 42, the current range resistance circuit 43, the differential amplifier 46, and a feedback circuit that consists of resistance 37. In addition, drawing 3 is positive and an example when the absolute value of the control current in negative constant-current mode is equal. When not equal, an inverting amplifier 22 is unnecessary and impresses reference voltage to resistance 33 from DA converter with 21 [another].
[0014] Here, the voltage range resistance circuit 12 and the current range resistance circuit 43 usually consist of FET switches which switch two or more range resistance and them. The voltage range resistance circuit 12 sets up the range of a control-voltage value, and DA converter 11 sets up the value in a range. In the case of a control current value, the current range resistance circuit 43 sets up a range, and DA converter 21 sets up the value in a range. Moreover, an integrating circuit consists of capacitors usually connected between the input of power amplifier, and grounding.
[0015] Furthermore, between I/O of the error amplifier 13, 24, and 34, clamping circuits 14, 25, and 35 are connected, respectively, and the output of error amplifier becomes more than the clamp voltage (Vc) decided by the clamping circuit.
[0016] Below, the relation of the input voltage pair output current of the voltage current repeaters 17, 28, and 38 is shown in drawing 6 . Although it changes in proportion [almost] to input voltage, the output current is set up so that it may be saturated in the range with the larger absolute value of input voltage than Vs of drawing 6 . The voltage current repeater 17 of V loop is the property of a point symmetry mostly to a zero, and the size of the saturation current is Is. On the other hand, it is in the property of the voltage-current converter 28 so that the saturation current by the side of right voltage may become zero mostly in the voltage-current converter 28 of Ip loop. - It is the property which required the bias of Is. Moreover, the voltage-current converter 38 of In loop is the property which required the bias of +Is. Moreover, input voltage does not become more than clamp-voltage Vc of above-mentioned error amplifier.
[0017] In addition, the inclination for a ramp of the input-output behavioral characteristics of these voltage-current converters does not need to be equal.
[0018] Below, operation of each loop is described. V loop presupposes first that feedback control is performed. At this time, the difference of a buffer amplifier 45, the voltage which returned to the input of the error amplifier 13 through resistance 16, and the voltage on which the voltage of DA converter 11 was applied to the input of the error amplifier 13 through the voltage range resistance circuit 12 is amplified with the error amplifier 13 from an output terminal 44, and the current which is equivalent to difference voltage from the voltage current repeater 17 is outputted. An integrating circuit 41 is integrated with this current, and it serves as an input of power amplifier 42. By the negative feedback of such a V loop, the ratio of the voltage of an output terminal 44 and the voltage of a DA converter balances so that it may become equal to the ratio of the resistance of resistance 16 and the voltage range resistance circuit 12. In this state, since, as for the input voltage of regularity 42, i.e., power amplifier, output voltage is maintained at simultaneously regularity, the current inputted into an integrating circuit 41 is zero mostly.
[0019] On the other hand, since the output current is a value smaller than a control current value while V loop is performing feedback control, the input of the error amplifier 24 of Ip loop has negative voltage of the size which saturates error amplifier. For this reason, the output of the error amplifier 24 is clamped by the voltage Vc positive by the clamping circuit 25. By moreover, the reason nil why the error amplifier 34 of In loop also has the conversely same polarity but - It is clamped by Vc. Therefore, Ip and In loop are in the state where feedback control cannot be carried out. Since the input voltage of the voltage-current converters 28 and 38 of Ip and In loop is set to Vc and -Vc, respectively at this time, the output current is zero mostly, as shown in drawing 6 . Although the sum of the current of three voltage-current converters is current inputted into an integrating circuit 41, the current of the voltage current repeater 17 is tuned finely, and a feedback circuit balances so that the flowing current may become zero mostly.
[0020] When Ip or In loop performs feedback control, except for the following point, it is the same as that of the case of V loop. That is, the voltage to which feedback voltage is proportional to the current of the ends of not output voltage but the current range resistance circuit 43 is returned. The resistance 23 and 33 of the position equivalent to a voltage range resistance circuit does not have the need for ranging. Moreover, the inverting amplifier 22 which reverses the polarity of DA converter 21 for Ip loop from which polarity differs, and In loop is formed. Furthermore, although omitted for details, as for the output current of each voltage-current converter in the state where the feedback circuit balances, not zero but the whole sum is zero.
[0021] Moreover, measurement of voltage and current is performed by the following method. The input impedance of the differential amplifier 46 is almost infinite, since the output voltage is proportional to the output current of a volt ampere characteristic measuring device, it can measure with the voltmeter which is not illustrating this voltage, and the current value which flows to the measuring object can be calculated. Moreover, since the output voltage of a buffer amplifier 45 is equal to the output voltage of a volt ampere characteristic measuring device, it can measure with the voltmeter which is not illustrating this voltage, and the voltage value of the measuring object can be calculated.
[0022] The example which changes from the source mode of a constant voltage shown in drawing 5 to constant-current-source mode describes operation which moves from one of the above-mentioned 3 modes to other modes. The introduction control-voltage value presupposes that V1 and a control current value are in the source mode of a constant voltage by I1. At this time, V loop performs feedback control, and is in equilibrium, and the error amplifier of Ip loop and In loop is clamped.
[0023] Here, supposing it enlarges a control-voltage value to V3, output voltage increases in feedback control operation of V loop, the output current increases, and it is going to exceed the control current value I1. At this time, the input voltage of the error amplifier 24 of Ip loop becomes close to zero, the error amplifier 24 is released from a clamp state, and the input voltage of the voltage current repeater 28 is also released from a saturation region. The voltage-current converter 28 absorbs current from an integrating circuit, in order to absorb current as shown in drawing 6 , if input voltage falls. On the other hand, by In loop, since a programmed current differs from the output current greatly, a clamp state is continued, and the current of the voltage-current converter 38 is maintaining the zero state. Consequently, it works in the direction in which Ip loop lowers the input voltage of power amplifier 42, and lowers output voltage further.
[0024] On the other hand, by V loop, since output voltage is still lower than the set point V3, the output of the error amplifier 13

increases and is made into how to flow out the output current of the voltage-current converter 17. Although the voltage-current converter 17 and the voltage-current converter 28 carry out operation of an opposite direction mutually here, as shown in drawing 6 , since the upper limit Is into which the voltage current repeater 17 can flow is smaller than the upper limit (about 2 Is (es)) of the current which can absorb the voltage-current converter 28, the voltage current repeater 17 is saturated previously. An output is raised and it will be in the state in which feedback control is impossible until the error amplifier 13 is also clamped after all. Thus, a feedback circuit balances in the state where the saturation current of the voltage current repeater 17 is absorbed by the voltage-current converter 28, V loop separates from the state of constant-voltage control, Ip loop will be in the state of carrying out constant current control, and the output current will be maintained at constant value.

[0025] In addition, when a voltage setup changes to V2 from V1, with a bird clapper, since there is no error voltage of an input of the error amplifier 24 of Ip loop in zero, it will maintain the armature-voltage control state of V loop to them, and will turn into voltage V2 soon at them.

[0026] As mentioned above, the volt ampere characteristic measuring device has two or more feedback circuits, in order to perform source mode of a constant voltage, positive-definite current-source mode, and negative constant-current-source mode. If at least one parameter which has determined the state of the feedback circuit in equilibrium is changed including that the frequency response of these feedback circuits is limited, and two or more pole for a ** reason, a spike and overshoot will occur in an output. Since two or more feedback circuits interchange the feedback operation idle state and feedback control operating state which have been saturated and clamped when the mode of a power supply changes, a big spike and big overshoot occur especially. Such spikes and overshoot give a unnecessary stress to a measuring object semiconductor.

[0027] Various methods of stopping a spike and an over shoot from the former have been devised. They are illustrated below.

[0028] (a) It is the method of stopping the abrupt change of a feedback loop, by inserting a low-passed type filter in the output of the DA converter which sets the method control-voltage value and control current value which prepare a filter as the output of a DA converter, and stopping the abrupt change of a DA converter output.

[0029] (b) Range change of the method control-voltage value which makes a DA converter zero temporarily at the time of voltage range change is the voltage range resistance circuit 12, and is performed by switching resistance (not shown). In order to prevent the spike at the time of ranging in the source mode of a constant voltage, and overshoot, it is the method of once making a setup of DA converter 11 into zero, changing range resistance in the state, and setting a DA converter as a desired value after that.

[0030] (c) If this voltage value becomes small in the method constant-current-source mode which carries out a makeup before breaking change in a voltage range resistance circuit in the setting change accompanied by change of a control-voltage value, when it will be predicted that mode changes arise, it is the method the resistance change (not shown) of a voltage range resistance circuit is made to become with makeup before breaking. Since parallel connection of the range resistance of two before and behind a change is temporarily carried out to the period of a change by this, output voltage does not sway during a change in the lower one. Therefore, the unnecessary loop changes under range resistance change are avoided, and a spike and generating of overshoot are suppressed.

[0031] (d) If this voltage value becomes large in the method constant-current-source mode which carries out a breaking before makeup change in a voltage range resistance circuit in the setting change accompanied by change of a control-voltage value, when it will be predicted that mode changes arise, it is the method the change of range resistance is made to serve as a breaking before makeup. Thereby, temporarily during the change, range resistance is small, with a bird clapper, there is nothing and output voltage does not sway to the larger one. Therefore, the unnecessary loop changes under range resistance change are avoided, and a spike and generating of overshoot are suppressed.

[0032] (e) In the source mode transformation method present constant-current-source mode of a constant voltage, when changing resistance (not shown) of the current range resistance circuit 43, change a control-voltage value and make it first, the source mode of a constant voltage compulsorily so that the present operating point may hardly change. Then, it is the method of changing the resistance of a current range resistance circuit.

[0033] (f) In the source mode of a method present constant voltage in which I loop is cut, when making a setting change accompanied by change of resistance of a current range resistance circuit, make the voltage-current converter of Ip loop and In loop into a functional idle state, and cut each feedback loop of Ip loop and In loop. After making a current-related setting change and completing all change, it is the method of reviving the feedback loop of Ip loop and In loop.

[0034] (g) Since the current range resistance circuit 43 is also the component of V loop even if it carries out a functional halt of the voltage-current converter of the soft switch method current loop, when switching current range resistance, a spike or overshoot will appear in an output. Then, it is the method of making it into ** to which the FET switch which switches current range resistance is driven by the lamp voltage wave, and change of range resistance becomes slower than the frequency response of V loop.

[0035] The above-mentioned conventional technology was combined, and it chose according to the present state, and the purpose which stops a spike and an over shoot can be attained. However, there are the following problems in these.

(1) Although one setting change is made, you have to operate two or more steps. Therefore, setting change takes time.

(2) Since a low pass filter, a soft switch, etc. of a DA converter make a setting change gradually, setting change takes time.

(3) Since the present mode must be supervised, a suitable method must be chosen from two or more change methods which predicted and mentioned the mode after setting change above and the sequence of operation must be switched, control is complicated and the burden of the firmware of an operation control section is size.

(4) According to above (1) and (2) term, a demand of the commercial scene of wanting to shorten the measuring time cannot be satisfied.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] according to this invention -- a spike and generating of overshoot -- enough -- it can stop -- the conventional technology -- several ms -- since -- the setting change time which required about 10ms can be shortened or less to 1/10 Consequently, it presents [can measure a semiconductor property now at high speed, and] practical use and is useful. furthermore, since the method of switching the control method according to the state where it is expected after required present state and setup with the conventional technology became unnecessary, control by the firmware reaches to an extreme, it can be simplified now, and shortening of a development cycle can be aimed at

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] this invention -- a spike and an over shoot -- stopping -- in addition -- and the volt ampere characteristic measuring device in which a high-speed setting change is possible is offered Furthermore the complicated control at the time of setting change of the conventional technology is simplified, and the load of the firmware which controls is mitigated.

[Translation done.]

MEANS

[Means for Solving the Problem] In addition to V loop, Ip loop, and In loop of the conventional technology, this invention newly establishes V hold loop. This loop has memorized output voltage by the output voltage store circuit at the time of the usual operation of a volt ampere characteristic measuring device. The feedback circuit of V hold loop is formed at the time of change of a control voltage and current value, and this feedback circuit maintains output voltage to the value in front of change on the basis of the storage voltage of an output voltage store circuit. Both a control-voltage value, and control current both [either or] are changed between them. When change is completed, the feedback circuit of V hold loop is cut and a volt ampere characteristic measuring device returns to a normal operating state.

[Translation done.]

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EXAMPLE

[Example] The basic composition of the example of this invention is shown in drawing 1 . The same sign is given to the component of the same function as the conventional technology. In addition, drawing 1 shows only the component about basic operation of a volt ampere characteristic measuring device, and components, such as an operation control section which performs amendment meanses, such as a feedback circuit, range change, and various signal processing and control, are omitted.
[0039] The basic composition of V hold loop is a loop which takes a round of the capacitor 1 which is an output voltage store circuit, the error amplifier 3, the FET switch 5, the voltage-current converter 7, an integrating circuit 41, power amplifier 42, the current range resistance circuit 43, and a buffer amplifier 45. An integrating circuit 41, power amplifier 42, the current range resistance circuit 43, and a buffer amplifier 45 are V loop of the conventional technology, Ip loop and In loop, and a common loop arrangement element.
[0040] There is two operating state, output voltage truck operation and output voltage maintenance operation, in V hold loop. Output voltage maintenance operation is operation of a period which changes the control voltage and current value of a volt ampere characteristic measuring device, and the purpose is maintaining output voltage to constant value. Output voltage truck operation is operation of the period of the normal operating state which change of a volt ampere characteristic measuring device completed, and the purpose is following output voltage and memorizing voltage.
[0041] In output voltage truck operation, the FET switch 5 is closed, the feedback loop of V hold loop is cut, and feedback control operation is stopped.
[0042] If the FET switch 5 is closed, since the error amplifier 3 will be in all feedback states and the input/output terminal will be held at a zero potential, a feedback loop is cut. Since the input terminal of error amplifier is maintained at zero, the potential of the terminal by the side of the error amplifier of a capacitor 1 is zero. Moreover, voltage with other terminals of a capacitor 1 equal to the output voltage of a buffer amplifier 45 to a volt ampere characteristic measuring device is always impressed. Consequently, voltage equal to a capacitor 1 to output voltage can always be charged.
[0043] When changing the control voltage and current value of a volt ampere characteristic measuring device, the feedback loop of V hold loop currently cut first is made to form, and it switches to output voltage maintenance operation. The FET switch 5 is opened to this. The voltage-current converter 7 of this loop has set up the dynamic range of a current output greatly from the voltage-current converter of V loop, Ip loop, and In loop, as the dotted line of drawing 7 shows. That is, it has set up beyond the value to which the current value at the time of saturation exceeds 3 times of the saturation current Is of the voltage-current converter 17.
[0044] If V hold loop forms a feedback loop, the difference voltage of the voltage charged by the capacitor 1 and voltage equal to the output voltage impressed from a buffer amplifier 45 is inputted into the error amplifier 3, and it is going to carry out feedback control of the V hold loop so that it may become zero about this difference voltage. Although V loop or I loop which carried out feedback control and had determined output voltage before it, and V hold loop compete for output voltage simultaneously, the voltage-current converter of V loop with the small die NAMMIKU range of a voltage-current converter or I loop is saturated previously, and, finally V hold loop comes to control. And the error amplifier of the loop which was carrying out feedback control till then will be in a clamp state.
[0045] Even if feedback control changes a control voltage and/or current value into during this period [from which it has moved to V hold loop] at a stretch, influence does not appear in an output. After completing change, if the loop of V hold loop is cut, feedback control will return to either V loop, Ip loop or In loop according to a new value.
[0046] Although a spike and overshoot are reduced by operation of V hold loop of the above-mentioned basic composition, a new spike and new overshoot may arise by changes between V hold loop and the usual loop. The detailed example which gave a means to have removed this and to improve the stability of feedback operation of V hold loop is shown in drawing 2 . However, drawing 2 shows only the component about basic operation, and components, such as an operation control section which performs amendment meanses, such as a feedback circuit including V hold loop, range change, and various signal processing and control, are omitted.
[0047] In drawing 2 , resistance 2 was inserted between the capacitor 1 of V hold loop, and the error amplifier 3, and the FET switch 4 is connected in parallel with this resistance. Moreover, the clamping circuit 6 is connected between a capacitor 1, the node of resistance 2, and the output terminal of the error amplifier 3. Furthermore, the FET switches 15, 26, and 36 are connected between I/O of the error amplifier of V loop, Ip loop, and In loop. These operations are described below.
[0048] (A) V hold loop changes the voltage current repeater of output voltage maintenance working, V loop, Ip loop, and In loop into an abeyance state. Generating of the spike which may be produced transitionally by this is prevented. The conversion efficiency of a voltage-current converter is with a bird clapper in equivalent at zero, and the abeyance state of a voltage current repeater is **. Therefore, in order to realize it, the interior of a voltage-current converter which cuts the input of a voltage current repeater is controlled, and an output is intercepted, or there is the method of intercepting an outgoing end.
[0049] (B) Make into a value almost equal to the feedback resister 16 of V loop resistance 2 inserted between the capacitor 1 and the input of the error amplifier 3, and improve the stability of the feedback loop of V hold loop. Resistance 2 is short-circuited with the FET switch 4, and it is made for the delay of a hold not to arise during output voltage truck operation.
[0050] (C) If the change of output voltage maintenance operation of V hold loop and output voltage truck operation is performed at a stretch, since a new spike occurs, the change timing of the FET switches 4, 5, and 7 will be adjusted according to the charge transfer from the FET switches 4 and 5 etc. by the soft change method which drives a change by the lamp wave.
[0051] (D) Since overshoot may occur when output voltage maintenance operation is completed and it returns to the usual

operation of a volt ampere characteristic measuring device if it is in the state where the error amplifier of V loop, Ip loop, and In loop was clamped for V hold loop during output voltage maintenance operation, short-circuit I/O of the error amplifier 13, 24, and 34 with the FET switches 15, 26, and 36 during output voltage maintenance operation, respectively.
[0052] (E) Connect a clamping circuit 6 to V hold loop, and prevent an FET switch malfunctioning during output voltage maintenance operation.
[0053] A spike and overshoot were lost by the above-mentioned method, and a high-speed setting change was attained by simple control.
[0054] Although the example of this invention was shown above, the format of instantiation, arrangement, and others are not limited, and deformation of composition is also permitted, without losing the summary of this invention if needed.

[Translation done.]

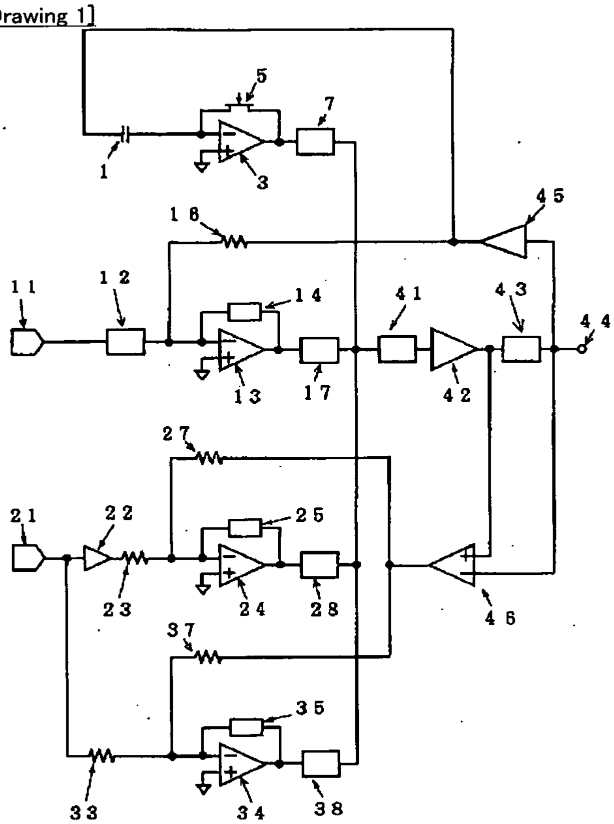
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the basic composition of the example of this invention.
[Drawing 2] It is drawing showing the more detailed composition of the example of this invention.
[Drawing 3] It is drawing showing the basic composition of the conventional technology.
[Drawing 4] It is drawing showing the output mode of a volt ampere characteristic measuring device.
[Drawing 5] It is drawing showing the example of changes of the output mode of a volt ampere characteristic measuring device.
[Drawing 6] It is drawing showing the input voltage of a voltage-current converter, and an output current property.
[Drawing 7] It is drawing showing the input voltage of a voltage-current converter, and an output current property.
[Description of Notations]
1: Capacitor
2: Resistance
3: Error amplifier
4: FET switch
5: FET switch
6: Clamping circuit
7: Voltage current repeater
11: DA converter
12: Voltage range resistance circuit
13: Error amplifier
14: Clamping circuit
15: FET switch
16: Resistance
17: Voltage current repeater
21: DA converter
22: Inverting amplifier
23: Resistance
24: Error amplifier
25: Clamping circuit
26: FET switch
27: Resistance
28: Voltage current repeater
33: Resistance
34: Error amplifier
35: Clamping circuit
36: FET switch
37: Resistance
38: Voltage current repeater
41: Integrating circuit
42: Power amplifier
43: Current range resistance circuit
44: Output terminal
45: Buffer amplifier
46: Differential amplifier

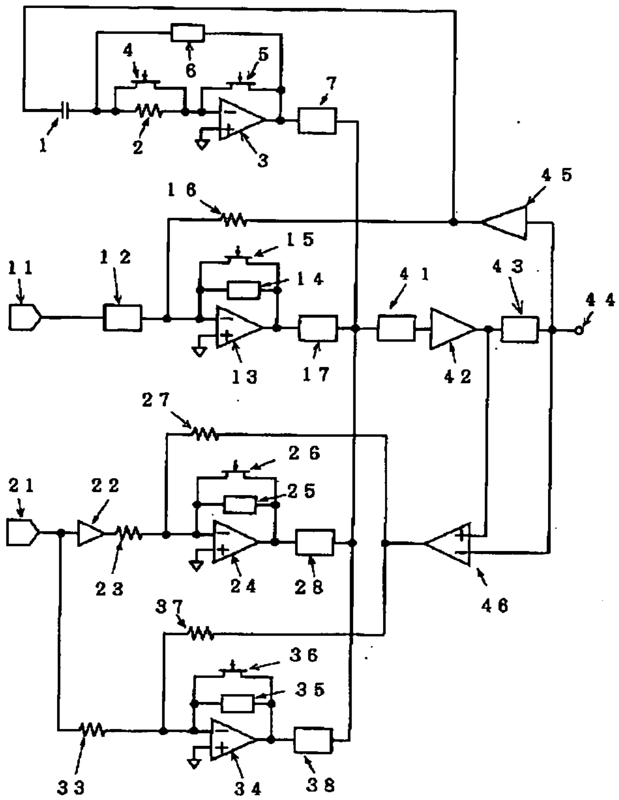
[Translation done.]

DRAWINGS

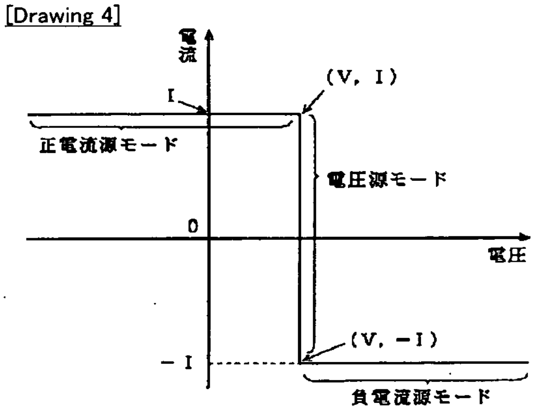
[Drawing 1]



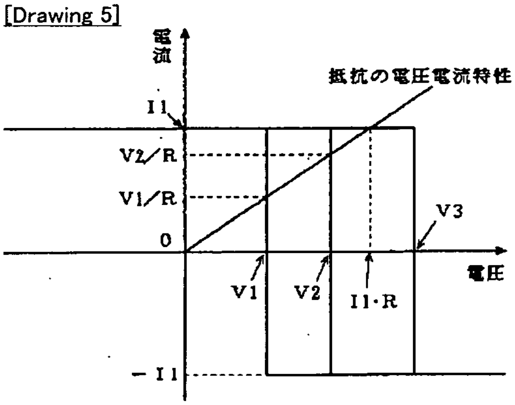
[Drawing 2]



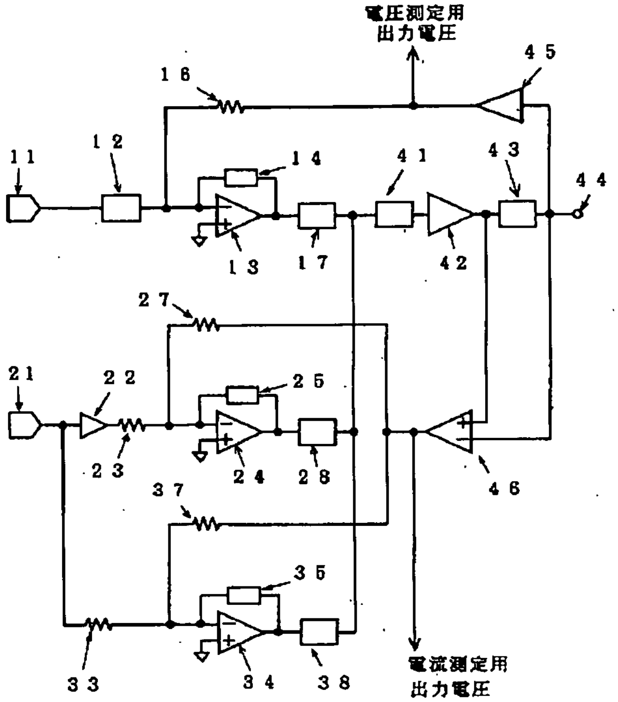
[Drawing 4]



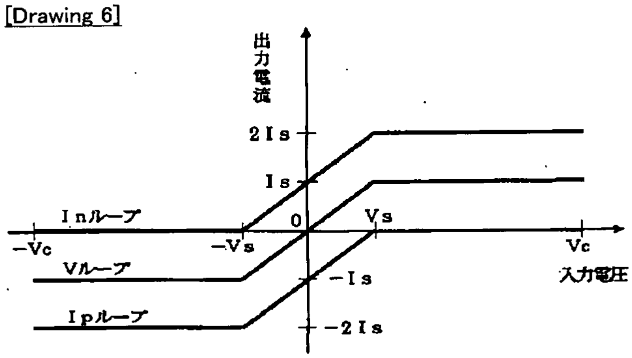
[Drawing 5]



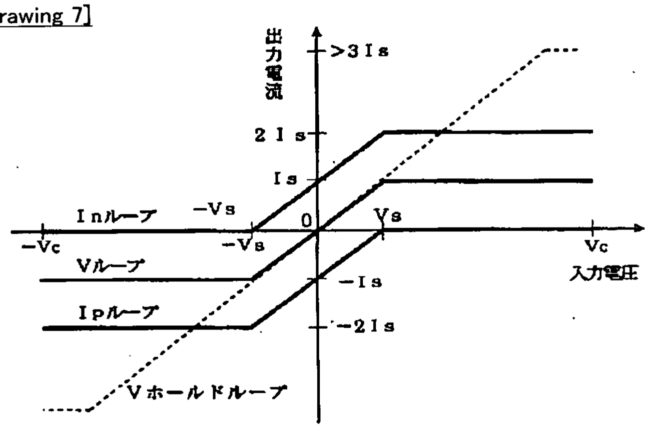
[Drawing 3]



[Drawing 6]



[Drawing 7]



[Translation done.]

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CORRECTION or AMENDMENT

[Official Gazette Type] Printing of amendment by the convention of 2 of Article 17 of patent law
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[Procedure revision]
[Filing Date] March 5, Heisei 14 (2002. 3.5)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Change
[Proposed Amendment]
[Claim(s)]
[Claim 1] The current range resistance circuit which detects the output current to which it connects with an output terminal and an end flows from the aforementioned output terminal to the measuring object,
The integrating circuit connected to the input of the power amplifier which drives the other end of the aforementioned current range resistance circuit, and the aforementioned power amplifier,
The 1st control means by which the 1st error amplifier to which the reference voltage for output voltage was connected through the output voltage detection means and voltage range resistance circuit which detect the voltage of the aforementioned output terminal is connected to the aforementioned integrating circuit through the voltage-current converter,
Have 2nd at least one control means by which the 2nd error amplifier to which the reference voltage for the output currents was connected through the output current detection means and resistance which detect the voltage of the ends of the aforementioned current range resistance circuit is connected to the aforementioned integrating circuit through the voltage-current converter, and it changes. In the volt ampere characteristic measuring device which controls the aforementioned output voltage by the 1st control means of the above to a predetermined value, or controls the aforementioned output current by the 2nd control means of the above to a predetermined value
It has a voltage storage means by which the end was connected to the aforementioned output voltage detection means, and the other end was connected to the input of the 3rd error amplifier, and the control means for switching connected between I/O of the aforementioned 3rd error amplifier, and has the 3rd control means by which the aforementioned 3rd error amplifier is connected to the aforementioned integrating circuit through the voltage-current converter.
When the 1st control means of the above or the 2nd control means is controlling the aforementioned output voltage or the output current, by the aforementioned control means for switching, the aforementioned voltage storage means changes to the state of memorizing the voltage of the aforementioned output voltage detection means, and the 3rd control means of the above memorize the aforementioned output voltage.